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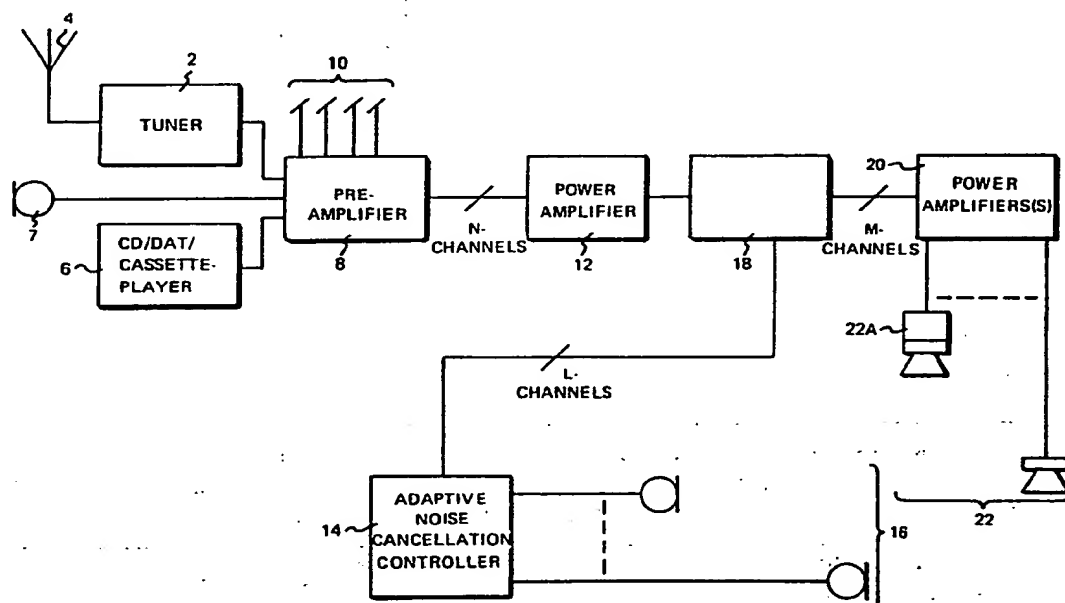
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(21) International Application Number: PCT/GB90/00230 (22) International Filing Date: 13 February 1990 (13.02.90) (30) Priority data: 8903201.5 13 February 1989 (13.02.89) GB (71) Applicant (for all designated States except US): GROUP LOTUS PLC [GB/GB]; Hethel, Norwich, Norfolk NR14 8EZ (GB). (72) Inventors; and (75) Inventors/Applicants (for US only): McDONALD, Anthony, Malcolm [GB/GB]; "Highfields", Mill Road, Barnham Broom, Norfolk NR9 4DE (GB). QUINN, David, Charles [GB/GB]; "Nirvana", The Street, Rocklands, Attleborough, Norfolk NR17 1UX (GB). PERRY, David, C. [GB/GB]; Somerset, Foundry Corner, Old Buckenham Road, Attleborough, Norfolk NR17 1NH (GB).		(74) Agent: JONES, Ian; Pollak, Mercer & Tench, High Holborn House, 52-54 High Holborn, London WC1V 6RY (GB). (81) Designated States: AT (European patent), BE (European patent), CA, CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent), US. Published With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: NOISE SUPPRESSION IN VEHICLES



(57) Abstract

An integrated noise reduction and communication and/or entertainment system for vehicle use includes one or more signal sources, selected for example from radio tuners (2), microphones (7), cassette decks (6) or the like, providing electrical outputs to be mixed with an electrical output from an adaptive noise reduction unit (14), in a balanced mixer (18), the mixer output being supplied to one or more loudspeakers (22, 22A) located at suitable positions in the vehicle cabin.

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NOISE SUPPRESSION IN VEHICLES

The invention relates to the suppression of unwanted noise in the cabins of vehicles, in particular road vehicles.

10 The driver and passengers of conventional passenger cars are exposed to a great deal of externally generated noise, due primarily to the vehicle engine. Various proposals have been made for cancellation or reduction of such noise by active
15 means, that is, by generating within the vehicle cabin sound vibrations of phase and amplitude such as to cancel, at least partially, the unwanted noise. An effective system of this kind is known from WO 88/02912 the contents of which are incorporated herein by
20 reference.

To achieve satisfactory results, such systems have to be of some complication, and they are consequently expensive. It is suggested in WO 88/02912 that the noise reduction system might make use, in respect of
25 motor vehicle interiors, of loudspeakers used as the low frequency drives of a car audio system, but this suggestion does not address the problem of effectively combining an entertainment system, which might employ only loudspeakers driven over the full audio frequency
30 spectrum, with a noise reduction system.

The invention accordingly provides an integrated entertainment and noise reduction system for use in a vehicle cabin, the system comprising a communication and/or entertainment signal source, a noise
35 cancellation signal source, at least one loudspeaker

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for mounting within the vehicle cabin, and a signal mixing device for mixing signals from the communication and/or signal source and the noise cancellation signal source, the loudspeaker receiving the mixed signal
5 output of the mixing device.

The invention can be carried into effect by provision of an integrated noise reduction and communication and/or entertainment system including one or more signal sources, selected for example from radio
10 tuners, microphones, cassette decks or the like, which sources provide electrical outputs to be mixed with an electrical output from a noise reduction unit, preferably an adaptive noise reduction unit, in a mixer, the mixer output being supplied to one or more
15 loudspeakers suitably located in the vehicle cabin.

In an otherwise conventional road vehicle, the active noise reduction system is preferably one which derives a reference signal from the internal combustion engine by which the vehicle is driven. The mixer
20 employed is preferably a balanced mixer, to reduce interference from the vehicle electrical system. The mixer is advantageously positioned in the system to receive the communication and/or entertainment signals downstream of selective control means for adjustment of
25 gain, treble and bass, etc. Typically, the system will operate over a plurality of channels and balancer and fader controls can then be provided for the communication and/or entertainment signals, again upstream of the mixer. The number of channels carrying
30 the mixed signals will not of course exceed the number of loudspeakers provided.

The invention is further described below, by way of example, with reference to the accompanying drawing, of which the single figure is a block circuit diagram
35 of an integrated audio communication and/or

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entertainment and noise reduction system embodying the invention.

The illustrated system includes, as entertainment components, at least one of a radio tuner 2, shown
5 connected to an aerial 4, and one or more decks 6 for playing compact discs, digitally recorded tapes, or tape cassettes. Instead of or as well as the signal sources represented by the tuner 2 and deck or decks 6, the system can include a microphone 7 usable by the
10 driver or other occupant of the vehicle for addressing its other occupants. The outputs from the signal source or sources of the system are fed to a pre-amplifier 8 fitted with appropriate control arrangements 10 for signal source selection and for
15 output adjustment, such as volume and bass and treble controls, or graphic equalization. The pre-amplifier 8 can operate on a single channel but typically provides its output signals on a plurality N of output channels, and balance and fader controls will then be provided.
20 The pre-amplifier output signals are supplied to a multi-channel power amplifier unit 12.

For noise reduction, the system includes a noise cancellation controller which is preferably adaptive and which may then advantageously be of the kind
25 described in WO 88/02912, the contents of which are incorporated herein by reference. Briefly, the function of the controller 14 is to provide, on a plurality L of output channels, outputs derived from a reference signal by adaptive filtering carried out by a
30 programmed microprocessor and memory unit in dependence on error signals from a plurality of microphones 16. The microphones 16 are located, preferably inconspicuously, at suitable spaced positions within the vehicle cabin. The reference signal may be derived
35 directly from the vehicle engine.

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The outputs from the amplifier 12 and the controller 14 are fed to a mixer 18, which is preferably a balanced mixer, in which the entertainment and/or communication signals are mixed with the noise cancellation outputs. The mixer 18 provides outputs for a second multi-channel power amplifier unit 20, the outputs of which are used to drive respective ones of a plurality of loudspeakers 20 located within the vehicle cabin at appropriate positions, which may be at the conventional loudspeaker positions. Some or all the loudspeakers 22 may be active loudspeakers if desired, for example, as indicated by loudspeaker 22A.

The integrated system of the invention thus provides that the noise reduction signals from the controller 14 are determined solely by the reference signal from which they are derived, under the adaptive control of the outputs of the microphones 16. The pre-amplifier control means 10 have no effect on them.

The system is provided with appropriate on/off and selection switches to provide in the cabin of a passenger motor car one or more of audio communication and entertainment and noise reduction, as the operator of the system may desire.

The loudspeakers 22 will normally correspond in number to the number of output channels of the pre-amplifier 8, but there may be a plurality of M channels between the balanced mixer 18 and the amplifier unit 20, where M is equal to or greater than the larger of the N entertainment channels or the L noise reduction channels.

The system described with reference to the drawing can be constituted either as an integrated system suitable as original equipment for a vehicle, or as a system obtained by adaptation of a road vehicle already provided with an "in-car entertainment" system (ICE).

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Such an ICE system will comprise one or both of the signal sources 2 and 6 and/or the signal source 7, the pre-amplifier 8, and the loudspeakers 22 together usually with one or other of the power amplifier units 5 12, 20. The integrated or combined system of the invention can readily be obtained by addition of the adaptive noise cancellation controller 14, the microphones 16 at suitable positions within the vehicle cabin, and by insertion of the balanced mixer 12 10 between the pre-amplifier outputs and the loudspeakers, with the provision of further amplifier means if needed. It will be understood that the power amplifier unit 12 may be omitted or combined as a single unit with the pre-amplifier 8. The amplifier unit 20 also 15 may be omitted if adequate amplification is provided elsewhere in the system.

It will be evident that the invention can be embodied in a variety of ways other than as herein described.

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CLAIMS

1. An integrated entertainment and noise reduction system for use in a vehicle cabin, the system comprising a communication (7) and/or entertainment
5 (2,6) signal source, a noise cancellation signal source (14), at least one loudspeaker (22) for mounting within the vehicle cabin, and a signal mixing device (18) for mixing signals from the communication and/or entertainment signal source and the noise cancellation
10 signal source, the loudspeaker receiving the mixed signal output of the mixing device.
2. An integrated system as claimed in claim 1 including selectively operable control means (10) for the signals from the communication and/or entertainment
15 signal source (2,6,7), the control means being located between the communication and/or entertainment signal source and the mixer.
3. An integrated system as claimed in claim 2 wherein the selectively operable control means (10) is
20 fitted to a pre-amplifier (8).
4. An integrated system as claimed in claim 1, 2 or 3 wherein the communication and/or entertainment signal source (2,6,7) provide a plurality of different output signals on respective ones of a plurality N of
25 separate signal channels, the noise reduction signal source (14) provides a plurality of different output signals on respective ones of a plurality L of separate signal channels and the mixer (18) provides a plurality of different output signals on respective ones of a
30 plurality M of separate output channels, where M is greater than or equal to the greater of L & N.
5. An integrated system as claimed in any preceding claim having power amplifier means located upstream (12) of the mixer (18) and/or between (20) the
35 mixer and the loudspeaker or loudspeakers (22).

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6. An integrated system as claimed in any preceding claim wherein the noise cancellation signal source (14) is adaptively responsive to the degree of cancellation achieved.

5 7. An integrated system as claimed in any preceding claim wherein the mixer (18) is a balanced mixer.

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 90/00230

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) *		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC ⁵ : G 10 K 11/16		
II. FIELDS SEARCHED		
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Classification System	Classification Symbols	
IPC ⁵	G 10 K	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched *		
III. DOCUMENTS CONSIDERED TO BE RELEVANT *		
Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
X	Patent Abstracts of Japan, vol. 10, no. 297 (E-444)(2353), 9 October 1986, & JP, A, 61112496 (NISSAN MOTOR CO. LTD) 30 May 1986 see the abstract	1, 2, 5
Y		6
A		4
X	US, A, 4052720 (M'GREGOR et al.) 4 October 1977 see column 6, line 48 - column 7, line 47	1
Y	WO, A, 88/02912 (ADAPTIVE CONTROL LTD) 21 April 1988 see the abstract cited in the application	6

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IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
16th May 1990	13.06.90	
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**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO.**

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 12/06/90. The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4052720	04-10-77	None	
WO-A- 8802912	21-04-88	GB-A- 2203016	05-10-88
		EP-A- 0285632	12-10-88
		GB-A- 2201858	07-09-88
		JP-T- 1501344	11-05-89

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